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Nijkamp, P.; Ratajczak, W.

2013

Faculty of Economics and Business Administration

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Research Memorandum 2013-37

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Abstract

This paper offers a concise holistic-historical perspective on regional science. It positions regional science among various related disciplinary approaches and presents a comprehensive image of its multi-faceted architecture.

Keywords

Spatial economy; location theory; triple-layer model; New Economic Geography; resilience; holistic.

1. Structure and Connectivity in Space

Regional science has a history of more than half a century old. It has found its roots in the explicit recognition of the importance of space in social science research. Space is not only an attribute of any phenomenon on earth (in terms of its geographical coordinates), but it also functions as a facilitator for or barrier to human interactions (Isard 1956, 1960).

Right from the outset there has been a debate on the semantics of 'regional science'. Regional science is a scientific endeavour that addresses the indigenous role of space (including regions, cities, environment, infrastructure, communication) in various social-science oriented issues, such as socio-economic disparities, regional and urban growth, or transport logistics. In the literature the question has sometimes been raised whether regional science should not be replaced by 'spatial science', a term that also nowadays is still often used in several countries. As argued by Barnes (2004), the term 'spatial science' (or perhaps 'spatial analysis') would have been a more appropriate description than 'regional science', but to avoid confusion with the rapidly emerging space technology in the 1950s and 1960s – addressing outer space studied by physical scientists and engineers –, the second best choice was 'regional science' (even though Isard's seminal work on *'Location and Space-Economy'* in 1956 still refers to space as the main scientific orientation). The predominant agenda item of regional science research was to complement the *'wonderland of no dimensions'* in conventional economics with a spatial plane. Admittedly, this goal was already set earlier by German location theorists in the first part of the twentieth century (for instance, Alfred Weber, August Lösch, Andreas Predöhl) and by predecessors in the nineteenth century (e.g. Johann-Heinrich von Thünen).

The central feature of regional science however, was to provide a rigorous analytical framework – often derived from mathematical theorizing – to connect several social science disciplines with the goal to develop testable theoretical structures and space-relevant concepts that were lending themselves to general applicability.

An important methodological question is clearly whether 'space' adds only an interesting geographical component to a given phenomenon (in terms of its coordinates, e.g.) or whether space is an intrinsic object of study. In the first case, cartographic mapping (e.g., geo-science, spatial information science) may bring along new representational and exploratory scientific results. In the second case, the notion of region, city, locality, connectivity or interaction is an essential ingredient of spatial research. Such a spatial unit is the playing field for economic, social, technological, institutional or regulatory forces. The history of regional science has shown that both research orientations have been extremely fruitful and have led to path-breaking

findings, in which theory development and applied analysis were running in tandem. In this way, also a bridge could be built between economics, geography, demography, planning, political science and public administration. In conclusion, a rich variety of real-world social science phenomena can be projected into geographical space (thus avoiding that such phenomena collapse in one point), but space is not only a passive attribute. There is an increasing awareness that geographical space plays also an *active* role: it determines industrial location, commuting patterns of residents, connectivity of cities, accessibility of inner cities, transport and migration flows, and so forth (see also Coffey 2003, Mulligan 2003).

This endeavour has turned out to be very successful (see Isard 2003). Regional science conferences have become mass meetings of often more than 1000 participants, the number and volume of regional science publications has shown a rapid rise over the past decades, and regional science has become a respected scientific approach, not in contrast to – but in tandem with – related disciplines, such as regional economics, urban economics, geography, transportation science, demography, planning, political science etc.

In the rich history of regional science various intriguing methodological research questions have emerged that directly touched on the *'raison d'etre'* of regional science. Examples are: What is a relevant spatial scale of analysis in regional science? Should the focus of regional analysis be on geographic entities (e.g., cities, settlements, industrial complexes, regions, interregional trade or transport) or on the behaviour of the economic objects in a concrete and given geographical space? If spatial movements and interactions take time, what is the relationship between space and time? If all spatial phenomena are linked together – but nearby things more than distant things (the so-called Law of Tobler 1970), – what are then the essential spatial connectivity (interaction or communication) principles? If a given geographic space acts as both a barrier and an opportunity, what does this mean for our explanatory analysis? And how are modern concepts from networks and complexity related to regional dynamics? Such questions do not have easily available answers. And therefore, the present paper has a modest scope: its aim is to seek for an operational framework for understanding the multiple and mutually interwoven dimensions of the structure and evolution of regional and urban phenomena as well as their interactions, in particular behavioural spatial patterns and governance modes.

This paper is organized as follows. Section 2 will offer a concise and selective description of some key issues in regional science. This will be followed by the design of a systemic conceptual framework for analyzing regional phenomena, based on a so-called Triple-Layer representation. Then, Section 4 will be devoted to a holistic perspective on the spatial economy, including space-time complexity issues. The paper will conclude with retrospective and prospective remarks.

2. Positioning Regional Science

Regional science originates from both *economics* and *geography*. On the economic side, its early roots can already be found in labour specialization and spatial labour division, in industrial organization and spatial industrial concentration, and in international trade and interregional transport (see for a review, Paelinck and Nijkamp 1980 and Ponsard 1983). Early predecessors were – next to classical economists – amongst others Johann-Heinrich von Thünen, Alfred Weber, Tord Palander, August Lösch and Andreas Predöhl.

Regional science finds its origin also in geography, in particular economic geography. The latter discipline derives its name from Emile Levassseur (1828-1911), a French economist and geographer (see Boureille 1998; Leroux and Hart 2012). Economic geography studies the spatial distribution of individual and economic activities – and their interdependencies – at various geographic scales, and their evolution over time (see Knox and Marston 2001; Clark et al. 2003; Warf 2006). Seminal contributions from economic geography to the foundations of regional science were inter alia provided by Walter Christaller, with his path-breaking conceptualization of the hierarchical distribution of places. Seminal contribution can be found in Isard (1956, 1979).

Regional science offers essentially a multidisciplinary perspective on the interface of both economics and economic geography. Regional science – sometimes also coined spatial science or spatial economics – studies the *where, what, how* and *for whom* questions in a complex space-economy. In so doing, it also employs notions from related disciplines, like transportation science, decision theory, political science, demography, sociology and the like. Regional science has very often exhibited a strong methodological – often statistical-econometric – orientation. Examples can be found inter alia in O'Sullivan (1981), McCann (2005), Brakman et al. (2009) and Capello and Nijkamp (2009).

Location theory has always formed the heart of regional science, first in the sense of industrial localization, but later on also in terms of residential location and facilities location. This has spurred an overwhelming volume of advanced studies on the foundations of the space-economy, including its complex space-time interactions. A concise review of the principles of location theory can be found in Gorter and Nijkamp (2001). In the course of time, location theory has been integrated in a much wider context of dynamic evolution of regions and cities. To a large extent, it has been mainstreamed with analytical spatial economics and economic geography, on the basis of a strong quantitative orientation (see also Fischer and Nijkamp 2013).

In recent years, we have witnessed an increasing popularity of the so-called New Economic Geography (NEG). NEG serves to find an interface between analytical economic geography and mainstream economics from a more conceptual theoretical perspective, with a clear emphasis on formal modelling exercises which take into account the heterogeneity in geography causing spatial disparities and imperfect competition. It places, therefore, particular emphasis on spatial agglomeration forces and regional growth convergence. Its first orientation was towards centre-periphery models, integrated regional and urban systems, and models of geographic agglomeration and trade, while later on the attention shifted to monopolistic competition issues, heterogeneity of production inputs, diversity in geographic space, spatial spread of industries, and heterogeneous preferences of economic actors.

According to Ascani et al. (2012) there are four characteristic features of NEG that distinguishes this discipline from regional science and related methodological frameworks:

- Increasing returns to scale in relation to the spatial unevenness of economic activity (explaining spatial concentration of industrial and human activity).
- Monopolistic competition in relation to the absence of perfectly competitive markets (inducing large industrial conglomerates).
- Transport costs in relation to locational choices, e.g. the 'iceberg' transport costs phenomenon (stimulating, for instance, multi-plant companies).
- External economies in relation to labour market pooling or technological spillover effects (inducing a spatial concentration of labour force and industries).

All in all, NEG has built up a solid formal apparatus, although its empirical and evidence-based underpinning is still feeble compared to modern applied modelling experiments in regional science. Its orientation is predominantly towards 'stylized facts'. It leans more on economics than on analytical economic geography, while it has provided only new insights in a limited domain of economic geography (in particular, locational analysis).

3. A Triple-Layer Representation of the Spatial Economy

The notion of space is fraught with many conceptual problems, both ontological and operational (see, for example, Russell 1976; Harvey 1990; Lefebvre 1991; Hillier 2007; Braun 2011). Space can be understood in a variety of contexts:

- Mathematical (abstract or absolute), in the sense of the metric (distance) that defines it;
- Physical, as a characteristic property of matter;
- Geographical, as a result of the evolution of nature (real space) outside a human influence;

- Social (relational), defined by relative distances (or inversed proximity) produced by human communities in the course of history;
- The entire surface of the earth, or parts of it (real space).

Space is the centrepiece of regional science. According to Ponsard (1988): "…its introduction does not mean corrections in detail; its introduction changes everything. Because space is not economically neutral".

There is a growing awareness among regional scientists that geographic space is not only a passive space (a projection of activities onto a two-dimensional plane), but increasingly also an active space. Several scholars have even agreed that in the past decades space has been de-humanized and objectified or that space was often seen as a dead or immobile entity based on positive measurements rather than on actions (see Graham 1997; Soja 1989). A more pronounced role of space – in terms of dynamic space or space-time evolution – has therefore been advocated in more recent years (see Thrift 1996). *The 'where'* question is more and more replaced by a *'how'* and '*why'* question on the geography of human activity. Furthermore, the role of point-based physical geography in the location of socio-economic activities has diminished, in favour of an increasingly important role of spatial interactions and communication. Consequently, even though the 'death of distance' hypothesis has largely been proven to overstate the importance of the emerging 'virtual reality', connectivity and accessibility – both physical and virtual – have become key concepts in modern regional science, next to traditional concepts like agglomeration and urbanization.

The currently popular NEG (see Fujita et al. 1999) reiterates these considerations by drawing attention to the close interwovenness between agglomeration and trade. The authors offer an attempt to re-track traditional economic geography (and regional science), while they also aim to build a new economics of space, based on a few rigorous economic principles. The authors start by observing a regrettable division line between mainstream economics and the economics of location and aim to build a bridge on the basis of a few simple (certainly not universally valid) concepts, in particular the imperfect competition model marked by increasing returns to scale (originating from Dixit and Stiglitz 1977). In an open (multi-region or multi-country) system various types of spatial agglomeration patterns may emerge, depending *inter alia* on transport costs, forward and backward linkages, and immobility of resources. The authors illustrate their arguments by referring to core-periphery phenomena, agriculture, urban systems, city size, transportation, international trade, and industrial clustering. Their study forms a good manifestation of the rigour of solid economic analysis for the explanation of the spatial patterns and evolution of economic activity. The shadow side of this study is that the authors have missed

out significant parts of the rich history of regional economics. Some examples may clarify this weakness in their study. First, any exposition on agglomeration advantages ought to start off from the basic economic principles laid down in growth pole, growth centre, or attraction pole theories developed by scholars such as Boudeville, Perroux, Richardson, or Klaassen. Now the book begins with an anecdotal story on the geographical concentration of secondhand bookshops in St. Martins's Court in London, but wasn't it Chamberlin who already before World War II pointed out similar phenomena in Harvard Square in Cambridge, Massachusetts? Furthermore, are there in our modern times no agglomeration disadvantages? The history of regional science offers many insightful and solid cornerstones for location principles.

A second example: the two pillars of regional economics are certainly formed by agglomeration economies and generalized transportation costs. Much emphasis is laid by the authors on the economic analysis of urbanization and scale advantages, but less on transportation costs. In our era of ICT development where many economists advocate the 'death of distance', it would have been necessary to pay more attention to both psychological and virtual distance costs, and their implications for the spatial organization of our world. The reference to Samuelson's iceberg metaphor may be insufficient to explain the emergence of global urban networks as a new geographical phenomenon.

And thirdly, there is no doubt a need for unifying principles, but the above study misses out some relevant cornerstones of (applied) spatial price and equilibrium theory, so convincingly and rigorously developed by regional economists such as Takayama, Labys, Berliant, Nagurney, Hewings, or Oosterhaven. In addition, there are also important contributions from spatial endogenous growth theory, recently developed in the spirit of Romer and Lucas by spatial economists such as Bröcker, Button, Poot, Stough, and many others. Similarly, recent fundamental contributions to spatial dynamics and complexity theory by Puu, Sonis, Reggiani, Camagni, and many others would certainly have deserved more attention.

Finally, to call central place theory in the Christaller-Lösch tradition at best a classification scheme is a misconception of Lösch' equilibrium theory and of the wealth of literature which has been published ever since (Lösch 1940). A reference to the fundamental regional and trade models of Tinbergen (1962) on the relevance of hierarchical economic principles for spatial economic equilibrium would have been appropriate in this context. Nevertheless, this study is an important milestone in the history of regional science, as it aims to build a bridge to mainstream economics. Indeed, regional science has over the past decades developed into a full-fledged and rigorous scientific approach to the spatial economy. It has immensely enriched our understanding of spatial complexities.

It should be added that the interplay of space and time is critical for a proper understanding of regional and urban dynamics. This interplay may exhibit both slow and fast dynamics, a space-time evolution based on interactive forces among all agents in space. This calls for the design and application of both conceptual and operational space-time models. Furthermore, several new contributions can be found in the interpretation of both space and time as continuous dimensions, rather than as discrete entities. As a result of advances in mathematical analysis of and statistical data bases on regional systems, we witness also a further generalization in spatial analysis by the inclusion of continuous space next to discrete space (see also Oud et al. 2012). The level of sophistication of spatial analysis has no doubt drastically increased over the past decades (see e.g. the Handbook of Regional Science by Fischer and Nijkamp 2013).

The playing ground of actors in regional science is occupied by economic agents and institutions. Thus, the real-world spatial (regional or urban) action platform in regional science exhibits patterns of location, allocation, accessibility and connectivity. This leads altogether to a Multi-level Activity Space that can be mapped out in three layers (see Figure 1).

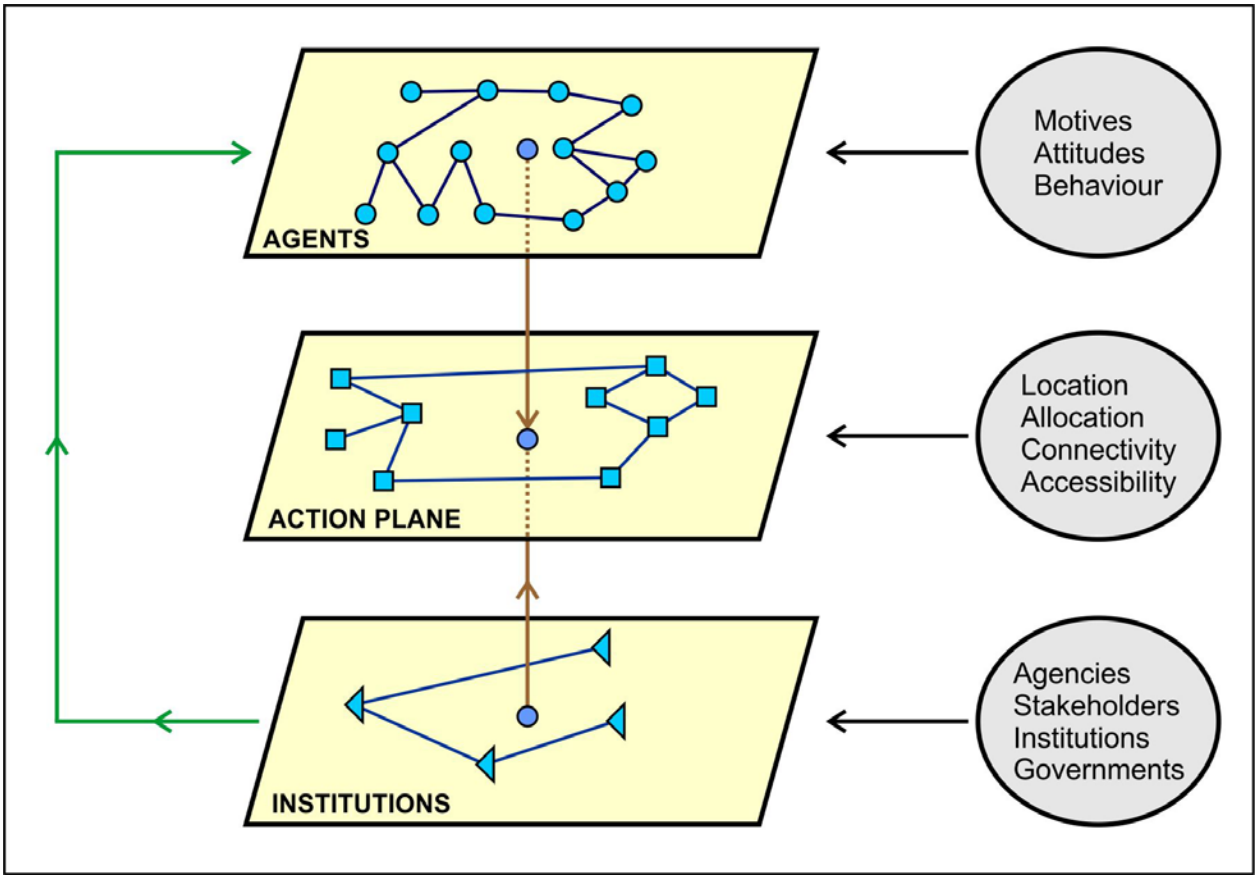

Figure 1. A triple-layer activity space of the spatial economy

The central middle layer in Figure 1 represents the spatial action platform where all forces (horizontal and vertical) come together. This is a complex force field influenced by individual agents (space users) and collective governance bodies. The role of the latter bodies may be partial and sectoral ('management in space') or comprehensive and integrated ('management of space'). Clearly, in a dynamically evolving system also space-time elements may have to be added. Agents and institutions altogether then create a dynamic interactive spatial-economic force field.

4. A Holistic Map of Regional Science

In the course of history, many regional science scholars have corroborated the role of space in explaining economic processes (Garrison 1959; Barnes and Gregory 1997). This merger of space and economics has resulted into a new branch of economics, complementary to economic geography and often coined spatial economics. It focuses the attention in particular on spatial analysis, based on a modern toolbox of quantitative research. This holds for many domains (such as urban economics or transportation economics) and issues (such as location theory, growth theory, theories on spatial behaviour, spatial competition, development theory).

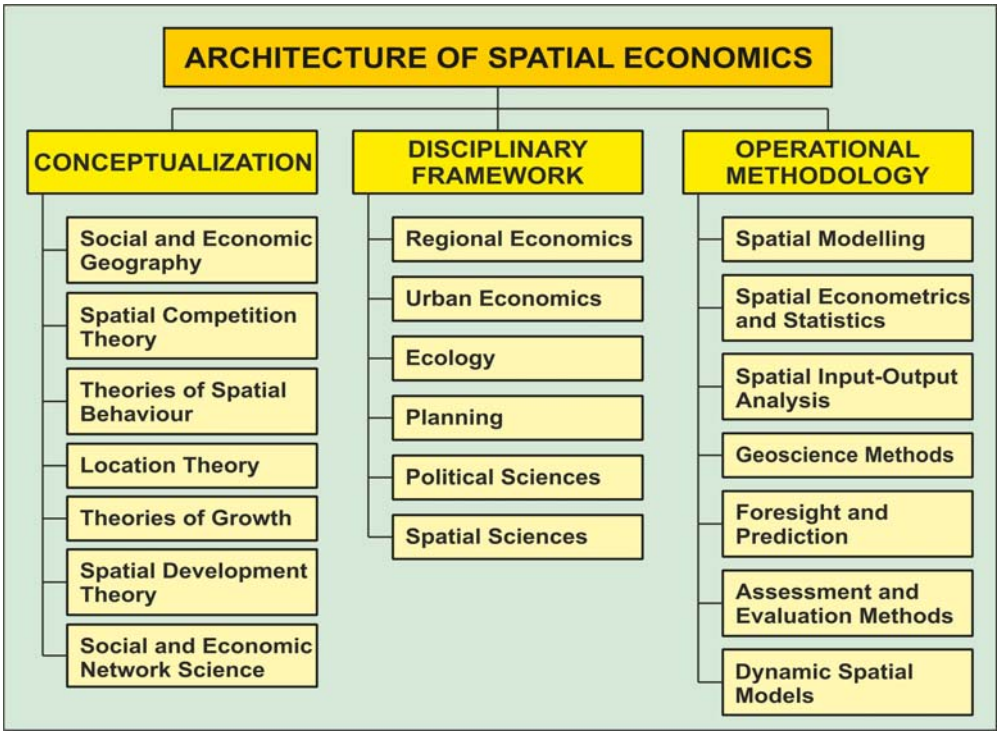

Figure 2. Spatial economics and its architecture

Clearly, spatial economics is partly overlapping with regional science and partly with socio-economic geography. From this perspective, NEG has a rather narrow scope, as it only addresses the economic aspects of geography (see Dymski 1996; Martin 1999; Thomas 2002; Bosker et al. 2007). It should be noted that, whether the term spatial economics is used or the term socio-economic geography – or in a broader sense, regional science – , all these scientific orientations are concerned with the spatial pattern and interaction of systems of production, distribution or consumption (or more generally, human activities) in a spatial context, including the management, planning and forecasting of spatial development. The methodological architecture of spatial economics is depicted in Figure 2.

The focus on human activity in space does not mean an exclusive orientation towards the economic geography of our planet. Human activities takes place in a broad force field and has to positioned in a broader context, in which many other disciplines and scientific domains play a role. This viewpoint calls essentially for a comprehensive holistic approach in which regional science, geography and other spatial disciplines are embedded (see also Goodchild et al. 2000; Goodchild and Janelle 2004).

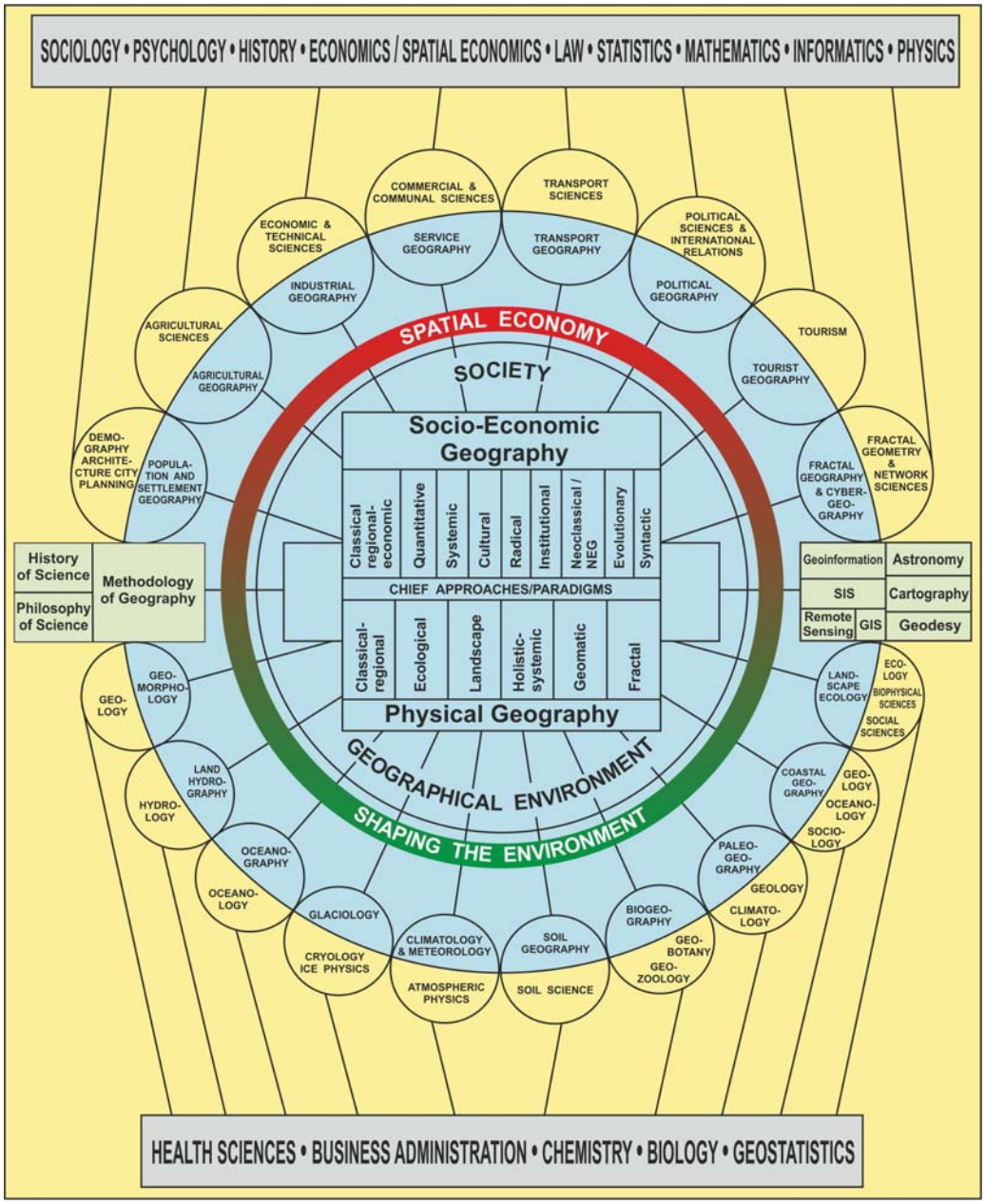

Figure 3. The spatial economy and its relations with complementary sciences

Legend: NEG – New Economic Geography, SIS – Spatial Information Systems, GIS – Geographic Information systems

This complex interdependent force field is mapped out in Figure 3. Clearly, such a conceptual framework is rich in scope and depicts the interfaces between real-world spatial phenomena and a variety of scientific orientations.

Finally, a focus on the real-world economic geography of our world, i.e. the spatial economy, prompts a variety of issues on management and governance of land use and scarce

space (O'Loughlin 2000; Soja 1997). Against this background, also political science, planning, public administration and land use management have to be mentioned as important constituents of a comprehensive view on the development of the spatial economy.

5. Retrospect and Prospect

It seems plausible that the future of regional science will be marked by many uncertainties on the dynamics of the spatial economy. Prominent sources of such uncertainties are: global population dynamics and its spatial distribution (including the urban-rural divide), the future of urbanization in an era where the megatrend is towards urbanized settlement patterns, the complementary (sometimes mutually supportive) interface between physical-material and virtual-digital spatial interaction, and the complexity of governance systems in an age of unprecedented spatial transformation in our world. All such phenomena call for advanced research tools in regional science, for instance, on individual-collective spatial behaviour, design of early warning systems, for critical transitions ('tipping points') in space, self-organizing or resilient systems models on adaptability and vulnerability in space, or data mining in case of large-scale or massive databases.

After the above exposition, it goes without saying that regional science is an '*Unvollendete*': there will always be more secrets behind the horizon which prompt our curiosity. Issues like the analysis of continuous space, the nature of spatial complexity, the future of data-driven models, the spatial importance of the digital society, or dynamic space-time interactions will be a source of scholarly concern and scientific inspiration. It is predictable that regional science in the future will not be a boring or dismal science!

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